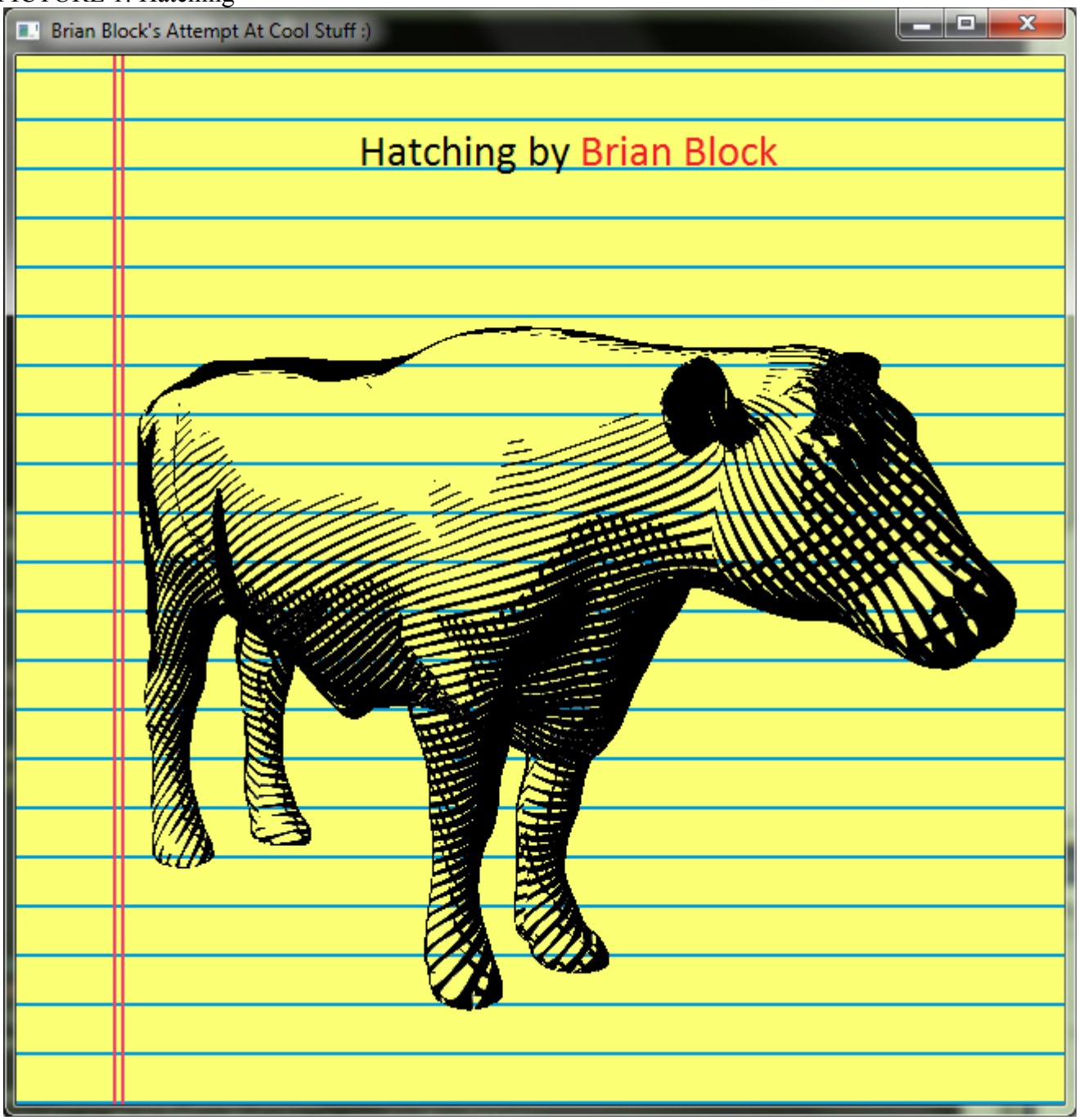
For my final project I choose to implement toon rendering: hatching and cell shading. It was my goal to make it look like my cow object looked as if it were drawn on my paper background. I did so by varying the frequency a wave form. By assigning a gray scale value from 0 to one in the 's' direction of the texture space and setting the texture parameters to gl repeat we can attain a sawtooth wave. From the sawtooth wave we can transform it into a triangle wave and using the step function on the triangle wave a square wave can be use to simulate pencil strokes. To draw pencil strokes perpendicular all that is needed is to sample the texture in the 't' direction performing the same calculations. Once I had the strokes to simulate lighting I varied the line widths, making them smaller in lighter areas and thicker in darker. By altering the line width with respect to the light intensity calculated using the light direction and normal. For better results I limited the perpendicular line strokes to only be drawn when light intensity is less than 0.3 and to not draw any lines when the light intensity is greater then 0.9 this yields more defined shadow/lit areas. To top it off I slapped on a silhouette shader to define the outline of the cow. Picture 1 illustrates the final results of my hatching. To give it transparency (the drawing effect) I turned on back face culling and killed pixels with a color value > 0.5 leaving only the black lines behind.

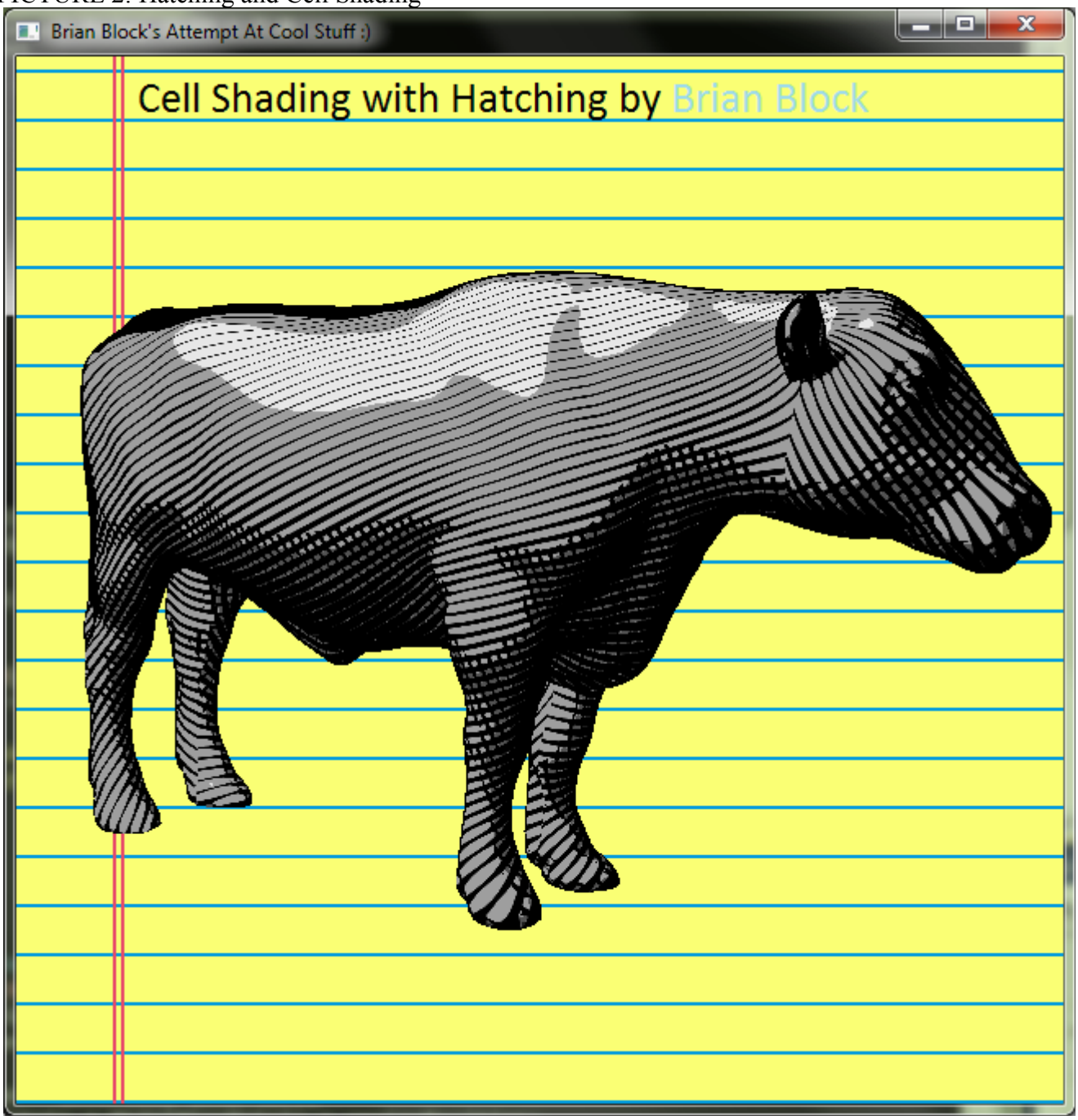
For the cell shading I added a gray gradient to the fragment shader. If the light intensity is > 0.9 then shade it almost white, if it is > 0.5 shade it gray , if it is > 0.3 shade it dark gray, otherwise black. This effect is combined with hatching to produce image #2.

Image #3 was using a method from a tutorial I found based off of the derivative of the texture coordinates, even though I implemented it wrong it yielded some nice effects :)

PICTURE 1: Hatching



PICTURE 2: Hatching and Cell Shading



PICTURE 3: